



STATE OF CALIFORNIA

GRANT REQUEST FORM (GRF)

CEC-270 (Revised 12/2019)

CALIFORNIA ENERGY COMMISSION

A) New Agreement # EPC-21-015

B) Division	Agreement Manager:	MS-	Phone
ERDD	Benson Gilbert	51	916-776-0763

C) Recipient's Legal Name	Federal ID Number
GreenFire Energy Inc	46-4587839

D) Title of Project
Steam Dominated GreenLoop: Proof of Concept at The Geysers, California

E) Term and Amount

Start Date	End Date	Amount
2/16/2022	3/31/2027	\$ 2,705,228

F) Business Meeting Information

☐ ARFVTP agreements \$75K and under delegated to Executive Director

Proposed Business Meeting Date 1/26/2022 ☐ Consent ☒ Discussion

Business Meeting Presenter Michael Ferreira Time Needed: 5 minutes

Please select one list serve. EPIC (Electric Program Investment Charge)

Agenda Item Subject and Description:

GREENFIRE ENERGY INC. Proposed resolution approving Agreement EPC-21-015 with GreenFire Energy Inc for a \$2,705,228 grant to advance the development of its Steam Dominated GreenLoop system in an existing low-production geothermal well, and adopting staff's determination that this action is exempt from CEQA. The system is intended to help restore power production of inactive or low production geothermal wells by extracting heat, but not water, via a closed loop, down bore heat exchanger. (EPIC funding) Contact: Michael Ferreira.

G) California Environmental Quality Act (CEQA) Compliance

1. Is Agreement considered a "Project" under CEQA?

☒ Yes (skip to question 2)

☐ No (complete the following (PRC 21065 and 14 CCR 15301)):

Explain why Agreement is not considered a "Project":

2. If Agreement is considered a "Project" under CEQA:

a) ☒ Agreement **IS** exempt.

☐ Statutory Exemption. List PRC and/or CCR section number:

☒ Categorical Exemption. List CCR section number: Cal. Code Regs., tit. 14, § 15301 ; Cal. Code Regs., tit. 14, § 15302

☐ Common Sense Exemption. 14 CCR 15061 (b) (3)

Explain reason why Agreement is exempt under the above section: The reasons for the CEQA categorical exemptions are listed below. CEC considered the CEQA findings of the Lead Agency, Lake County, to reach its own conclusions, below, on the project:

**1. For Cal. Code Regs. (CCR), Title 14, Section 15301(b) (Existing Facilities):**

Section 15301 exempts the operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of existing or former use, this includes in subsection (b): "Existing facilities of both investor and publicly-owned utilities used to provide electric power, natural gas, sewerage, or other public utility services." This project will retrofit an existing geothermal production well to demonstrate the ability of the SDGL system to deliver enthalpy to the surface without extracting water or reducing well pressure. This is an existing facility with no or negligible expansion of an existing use.

2. For Cal. Code Regs. (CCR), Title 14, Section 15302 (c) (Replacement or Reconstruction of Existing Utility Systems): Section 15302 exempts the replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced, this includes in subsection (c): "Replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity." The existing geothermal production well identified for use to act as the proof of concept project well for the SDGL system is an intermittently producing low production well. No new drilling of the well will be performed as part of the project. Instead, a down bore heat exchanger (DBHX) composed principally of vacuum insulated tubing will be inserted into the existing well and a new well head component (a header) will be added on the surface to properly suspend the DBHX in the selected well. Water will be circulated in the DBHX to capture heat from the well, principally from the latent heat of vaporization associated with the condensation of steam from the geothermal resource on the DBHX, which heat will be transported to the surface by the water circulated in the DBHX. At the surface, instrumentation will be added to measure and assess the performance of the SDGL system and the DBHX. Analysis has suggested that with the SDGL system the well will be able to produce consistently, rather than intermittently, but the total power that can be produced from the well at any specific time will not be substantially increased.

- b) Agreement **IS NOT** exempt. (consult with the legal office to determine next steps)

Check all that apply

- ☐ Initial Study
- ☐ Negative Declaration
- ☐ Mitigated Negative Declaration
- ☐ Environmental Impact Report
- ☐ Statement of Overriding Considerations



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H) List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)

Legal Company Name:	Budget
Manuel Weyman Group, Inc.	\$ 0 (Match Funding)
Lawrence Berkeley National Laboratory	\$ 250,578
Engineering Subcontractor (TBD)	\$ 90,000

I) List all key partners: (attach additional sheets as necessary)

Legal Company Name:

J) Budget Information

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	20-21	301.001H	\$2,705,228

R&D Program Area: EDMFO: EDMF

TOTAL: \$ 2,705,228

Explanation for "Other" selection

Reimbursement Contract #: Federal Agreement #:

K) Recipient's Contact Information**1. Recipient's Administrator/Officer**

Name: Joseph Scherer

Address: 5932 Ostrander Road

City, State, Zip: Oakland, CA
94618

Phone: 415-200-8302

E-Mail:

joseph.scherer@greenfireenergy.co
m**2. Recipient's Project Manager**

Name: Fred Manuel

Address: 16500 Wedge Pkwy Ste
400City, State, Zip: Reno, NV 89511-
3317

Phone: 775-683-9230

E-Mail: fred.manuel@mwgcorp.com

L) Selection Process Used

- ☒ Competitive Solicitation Solicitation #: GFO-20-301
- ☐ First Come First Served Solicitation Solicitation #:
- ☐ Non-Competitive Bid Follow-on Funding (SB 115)

M) The following items should be attached to this GRF

- | | |
|---|--|
| 1. Exhibit A, Scope of Work | ☒ Attached |
| 2. Exhibit B, Budget Detail | ☒ Attached |
| 3. CEC 105, Questionnaire for Identifying Conflicts | ☒ Attached |
| 4. Recipient Resolution ☒ N/A | ☐ Attached |



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5. CEQA Documentation

☐ N/A

CALIFORNIA ENERGY COMMISSION
☒ Attached

Agreement Manager

Date

Office Manager

Date

Deputy Director

Date

Exhibit A
Scope of Work
GreenFire Energy Inc.

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR¹	Task Name
1		General Project Tasks
2		Well, Reservoir, and Systems Modeling
3	X	Well Engineering
4		Surface Systems Engineering
5		Site Work - SDGL Equipment Installation
6		Project Operations
7		Evaluation of Project Benefits
8		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
KGRA	Known Geothermal Resource Area
Project Host	<i>Project Host</i> is the owner of the geothermal facility where the SDGL system will be demonstrated.
SDGL	<i>Steam Dominated Green Loop (SDGL)</i> technology refers to the sum of equipment used to extract energy from a steam dominated reservoir production well and transfer it to surface mounted heat exchange equipment used for power generation.
TAC	Technical Advisory Committee

PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

The purpose of this agreement is to fund a “proof of concept” project that, if successful, may lead to commercial projects to restore power production of inactive or low production wells using a closed loop, down bore heat exchangers. This project may not only lead to the retrofit of geothermal wells in California but may also demonstrate the ability of Steam Dominated Green Loop (SDGL) equipment to expand or develop fields that lack sufficient water to maintain adequate field pressure.

¹ Please see subtask 1.3 in Part III of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

Exhibit A

Scope of Work

GreenFire Energy Inc.

B. Problem/ Solution Statement

Problem

The key problems limiting geothermal growth in California are the cost and risk of drilling new production wells coupled with the failure to halt the decline of existing production wells and resources. These factors must be addressed now if California is to meet its mandate for geothermal power generation. In many steam dominated geothermal fields expansion is not possible because adding new conventional wells simply further depletes the declining resource while risking production decreases for other conventional wells in the same field. Conventional well “workovers” to fix failed or declining wells are costly, slow, risky, and also deplete the resource.

Solution

The most direct and rapid solution to declining geothermal power in California is to harvest heat from known geothermal fields. But, for many fields, this must be done without extracting water. Extracting heat but not water can be done using the Recipients down bore heat exchanger technology adapted for steam dominated fields. The Recipient has demonstrated the fundamental aspects of SDGL technology by successfully completing a CEC-funded demonstration of a closed-loop geothermal energy system in an inactive well at Coso, California. That project proved the potential for power generation via a closed loop, down bore heat exchanger and validated the thermodynamic model used to design the project.

This project propels closed-loop geothermal systems into the commercial realm at the world’s largest single geothermal field – The Geysers in northern California. Discussions with the Project Host have revealed a substantial number of wells at The Geysers that might be restored using the Recipient’s proprietary SDGL technology. Further, success with SDGL well retrofits will provide the operating data needed to contemplate the next step – a large new geothermal project at The Geysers using SDGL technology.

The commercial success of closed-loop geothermal systems will help California to meet its stated goal of 1,000 MW additional geothermal capacity by 2025. Closed-loop systems substantially reduce the cost, risk, and time needed for new projects, and provide a quick, low- cost way to fix wells that fail initially or over time. The Recipient’s specially designed closed-loop geothermal systems can be implemented to produce power without consuming subsurface water and pressure. This capability overcomes the need for enormous volumes of water that has curtailed development of geothermal production in water-constrained California.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Demonstrate that SDGL technology can enable the geothermal industry to overcome the specific technical issues that have impeded the development of geothermal power in the State of California, particularly in steam dominated resources.
- Retrofit one geothermal production well with Recipient’s SDGL technology.

Exhibit A

Scope of Work

GreenFire Energy Inc.

Ratepayer Benefits:²

The goals of this Agreement include delivering ratepayer benefits of greater electric reliability and lower cost with superior environmental attributes. The SDGL technology has the potential to make well retrofits the least expensive way to produce additional geothermal power. Low-cost geothermal power is also an environmentally attractive way to improve grid resiliency. Because retrofit projects use existing wells, infrastructure, and transmission, the return on investment and return on assets for investors are improved, making geothermal an attractive investment for California.

Geothermal power projects provide secure long-term jobs in construction, operations, maintenance, and administrative support. Based on studies performed by “Geothermal Rising” (Formerly the Geothermal Resources Council), geothermal projects provide important economic benefits for both workers, communities, and power consumers alike. Consider the following benefits:

- 2.1 jobs (direct and indirect) per MW. The majority of these jobs are local and thereby directly contribute to the communities where these resources are located.
- Up to \$350,000 per year in property taxes paid for a representative 20 MW facility.
- Royalty payments of up to \$22 million per year, 75% of which is returned to the state and counties for a representative 20 MW facility.
- Among the smallest footprint per kilowatt of power generation technologies.
- No impact on safety.
- Grid stabilization as intermittent renewables comprise a greater percentage of overall power generation.

Technological Advancement and Breakthroughs:

This Agreement is intended to lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California’s statutory energy goals. This project will advance the knowledge of designing downhole heat exchangers to effectively transfer geothermal energy from deep in the geothermal reservoir to bring heat to the surface while preserving water mass and pressure in the reservoir. In other words, this project will be the first geothermal energy project to extract heat without consuming subsurface water. This capability is crucial to developing many of California’s depleted or water-challenged geothermal resources making them sustainable over the long-term.

Agreement Objectives

The objectives of this Agreement are to:

- Demonstrate the ability of a downhole heat exchanger in a closed loop system to produce to the surface 80% or more of the enthalpy available at the depth from a particular steam feed zone supplying a test well without an appreciable reduction in water mass or pressure in the resource.

² California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC “Phase 2” Decision 12-05-037 at page 19, May 24, 2012, http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF).

Exhibit A Scope of Work GreenFire Energy Inc.

- Document engineered systems process flow and reservoir modeling agree with measured data within defined tolerances for an application where no appreciable water mass or pressure is removed from the production well.
- Use the performance data, resource data, and applicable cost figures to estimate the technical and economic feasibility, including the estimated levelized cost of electricity production, for a large-scale project capable of producing over 100MWe or more in the northwest quadrant of The Geysers KGRA.

II. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V)**. All products submitted which will be viewed by the public, must comply with the accessibility requirements of Section 508 of the federal Rehabilitation Act of 1973, as amended (29 U.S.C. Sec. 794d), and regulations implementing that act as set forth in Part 1194 of Title 36 of the Federal Code of Regulations. All technical tasks should include product(s). Products that require a draft version are indicated by marking “**(draft and final)**” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, “**days**” means working days.

The Recipient shall:

For products that require a draft version, including the Final Report Outline and Final Report

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Consider incorporating all CAM comments into the final product. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product.
- Submit the revised product and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period, or approves a request for additional time.

For products that require a final version only

- Submit the product to the CAM for acceptance. The CAM may request minor revisions or explanations prior to acceptance.

For all products

- Submit all data and documents required as products in accordance with the following:

Exhibit A

Scope of Work

GreenFire Energy Inc.

Instructions for Submitting Electronic Files and Developing Software:

- **Electronic File Format**

- Submit all data and documents required as products under this Agreement in an electronic file format that is fully editable and compatible with the California Energy Commission's (CEC) software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick.

The following describes the accepted formats for electronic data and documents provided to the CEC as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

- **Software Application Development**

Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

- Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the CEC's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

Subtask 1.2 Kick-off Meeting

The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.

Exhibit A

Scope of Work

GreenFire Energy Inc.

The Recipient shall:

- Attend a “Kick-off” meeting with the CAM, the Commission Agreement Officer (CAO), and any other CEC staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:

- Terms and conditions of the Agreement;
- Invoicing and auditing procedures;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
 - An updated Project Schedule;
 - Technical products (subtask 1.1);
 - Progress reports (subtask 1.5);
 - Final Report (subtask 1.6);
 - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
 - Any other relevant topics.
- Provide *Kick-off Meeting Presentation* to include but not limited to:
 - Project overview (i.e., project description, goals and objectives, technical tasks, expected benefits, etc.)
 - Project schedule that identifies milestones
 - List of potential risk factors and hurdles, and mitigation strategy
 - Provide an *Updated Project Schedule*, *Match Funds Status Letter*, and *Permit Status Letter*, as needed to reflect any changes in the documents.

The CAM shall:

- Designate the date and location of the meeting.
- Send the Recipient a *Kick-off Meeting Agenda*.

Recipient Products:

- Kick-off Meeting Presentation
- Updated Project Schedule (*if applicable*)
- Match Funds Status Letter (subtask 1.7) (*if applicable*)
- Permit Status Letter (subtask 1.8) (*if applicable*)

CAM Product:

Exhibit A

Scope of Work

GreenFire Energy Inc.

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive CEC funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the CEC and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient and may include the CAO and any other individuals selected by the CAM to provide support to the CEC.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the CEC, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

- Prepare and submit a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* with a list of expected CPR participants in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a schedule for providing a Progress Determination on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)

CAM Products:

- CPR Agenda
- Progress Determination

Exhibit A

Scope of Work

GreenFire Energy Inc.

Subtask 1.4 Final Meeting

The goal of this subtask is to complete the closeout of this Agreement.

The Recipient shall:

- Meet with CEC staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

- The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
- The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
 - Disposition of any procured equipment.
 - The CEC's request for specific "generated" data (not already provided in Agreement products).
 - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
 - "Surviving" Agreement provisions such as repayment provisions and confidential products.
 - Final invoicing and release of retention.
- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide copies of *All Final Products* on a USB memory stick, organized by the tasks in the Agreement.

Products:

- Final Meeting Agreement Summary (*if applicable*)
- Schedule for Completing Agreement Closeout Activities
- All Final Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
 - Summarize progress made on all Agreement activities as specified in the scope of work for the preceding month, including accomplishments, problems, milestones, products, schedule, fiscal status, and an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the

Exhibit A

Scope of Work

GreenFire Energy Inc.

Progress Report Format Attachment for the recommended specifications.

- Submit a monthly or quarterly *Invoice* that follows the instructions in the “Payment of Funds” section of the terms and conditions, including a financial report on Match Funds and in-state expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. When creating the Final Report Outline and the Final Report, the Recipient must use the CEC Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Energy Commission Style Manual* provided by the CAM.

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Energy Commission Style Manual
- Comments on Draft Final Report Outline
- Acceptance of Final Report Outline

Subtask 1.6.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Energy Commission Style Manual, and Final Report Template provided by the CAM with the following considerations:
 - Ensure that the report includes the following items, in the following order:
 - Cover page (**required**)
 - Credits page on the reverse side of cover with legal disclaimer (**required**)
 - Acknowledgements page (optional)
 - Preface (**required**)
 - Abstract, keywords, and citation page (**required**)
 - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
 - Executive summary (**required**)
 - Body of the report (**required**)
 - References (if applicable)
 - Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)

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Scope of Work

GreenFire Energy Inc.

- Bibliography (if applicable)
- Appendices (if applicable) (Create a separate volume if very large.)
- Attachments (if applicable)
- Submit a draft of the Executive Summary to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments* received on the Executive Summary. For each comment received, the recipient will identify in the summary the following:
 - Comments the recipient proposes to incorporate.
 - Comments the recipient does propose to incorporate and an explanation for why.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.
- Submit the revised *Final Report* electronically with any Written Responses to Comments within 10 days of receipt of CAM's Written Comments on the Draft Final Report, unless the CAM specifies a longer time period or approves a request for additional time.

Products:

- Summary of TAC Comments
- Draft Final Report
- Written Responses to Comments (*if applicable*)
- Final Report

CAM Product:

- Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of CEC funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the CEC awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

If match funds were a part of the proposal that led to the CEC awarding this Agreement, then provide in the letter:

Exhibit A

Scope of Work

GreenFire Energy Inc.

- A list of the match funds that identifies:
 - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
 - If different from the solicitation application, provide a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter (*if applicable*)
- Match Funds Reduction Notification Letter (*if applicable*)

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
 - The schedule the Recipient will follow in applying for and obtaining the permits.

The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not

Exhibit A

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obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits (*if applicable*)
- Updated Schedule for Acquiring Permits (*if applicable*)
- Copy of Each Approved Permit (*if applicable*)

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Recipient shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of each executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Products:

- Subcontracts (*draft if required by the CAM*)

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
 - Technical area expertise;

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- Knowledge of market applications; or
- Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.
- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate, to the extent the TAC members feel is appropriate, on behalf of the project in its effort to build partnerships, governmental support and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project's strategic goals.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;
- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

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- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings

The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

The Recipient shall:

- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

The TAC shall:

- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate on behalf of the project in its effort to build partnerships, governmental support and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project's strategic goals.
- Review and provide comments to proposed project performance metrics.
- Review and provide comments to proposed project Draft Technology Transfer Plan.

Products:

- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

Subtask 1.12 Project Performance Metrics

The goal of this subtask is to finalize key performance targets for the project based on feedback from the TAC and report on final results in achieving those targets. The performance targets should be a combination of scientific, engineering, techno-economic, and/or programmatic

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metrics that provide the most significant indicator of the research or technology's potential success.

The Recipient shall:

- Complete and submit the project performance metrics from the *Initial Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task, to the CAM.
- Present the draft project performance metrics at the first TAC meeting to solicit input and comments from the TAC members.
- Develop and submit a *TAC Performance Metrics Summary* that summarizes comments received from the TAC members on the proposed project performance metrics. The *TAC Performance Metrics Summary* will identify:
 - TAC comments the Recipient proposes to incorporate into the *Initial Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task.
 - TAC comments the Recipient does not propose to incorporate with and explanation why.
- Develop and submit a *Project Performance Metrics Results* document describing the extent to which the Recipient met each of the performance metrics in the *Final Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task.
- Discuss the *Project Performance Metrics Results* at the Final Meeting.

Products:

- TAC Performance Metrics Summary
- Project Performance Metrics Results

III. TECHNICAL TASKS

TASK 2 WELL, RESERVOIR, AND SYSTEMS MODELING

The goals of this task are to:

- Model hydraulic, thermodynamic, and chemical performance of designated production well as mutually agreed by the Recipient and Project Host, and
- Model the wellbore and down bore heat exchanger performance as well as surface systems to optimize heat transfer from the resource for power production.

The Recipient shall:

- ****IMPORTANT NOTE:** Products/deliverables submitted for this task to the CEC should not disclose any confidential information.
- Gather required information from the Project Host regarding production well design and performance in order to allow construction of an accurate model.
- Construct operational models of the wellbore and down bore heat exchanger performance as well as surface heat transfer equipment simulating SDGL operation.
- Authorize and supervise a project partner as a 3rd party expert to construct operational models of the wellbore and reservoir performance regarding the anticipated geochemical reaction to SDGL at the test location.
- Coordinate meetings with the Project Host and others as needed to communicate model results and identify project constraints.
- Propose options and alternatives as may be necessary for project implementation.

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- Prepare a draft *SDGL Model Report* and submit to the CAM for feedback.
- The *SDGL Model Report* should include, but is not limited to the following:
 - High-level executive summary
 - Wellbore hydraulic model
 - Wellbore thermal model
 - Analysis and/or commentary on operational sustainability.
- Incorporate changes as requested by the CAM in the final *SDGL Model Report*.

Products:

- *SDGL Model Report* (draft and final)

TASK 3 WELL ENGINEERING

The goal of this task is to complete all engineering activities for subsurface systems. Well engineering incorporates modeling results and well test data to determine the appropriate metallurgy and design of the downhole components, downhole testing equipment, and well head.

The Recipient shall:

- ****IMPORTANT NOTE:** Products/deliverables submitted for this task to the CEC should not disclose any confidential information.
- Design the downhole casing appropriate for the pressure and heat transfer duty taking into consideration any potential chemical attack as identified in Task 2.
- Design the vacuum insulated tubing (VIT).
- Design the well head.
- Create an initial design for the *SDGL* installation (downhole and surface equipment).
- Develop *Well Engineering Design Drawings and Specifications Report*, which should include, but is not limited to the following:
 - High-level executive summary
 - Downhole casing design
 - Vacuum insulated tubing (VIT) design
 - Well head design
- Prepare *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting per subtask 1.3, which should take place after the *Well Engineering Design Drawings and Specifications Report* is submitted.

Products:

- *Well Engineering Design Drawings and Specifications Report*
- *CPR Report #1*

TASK 4 SURFACE SYSTEMS ENGINEERING

The goal of this task is to complete all engineering activities for surface systems. Surface systems engineering determines the appropriate equipment to be designed, procured, fabricated, delivered, and erected onsite for the testing program.

The Recipient shall:

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- ****IMPORTANT NOTE:** Products/deliverables submitted for this task to the CEC should not disclose any confidential information.
- Produce a *Process Flow Diagram* with flows and thermodynamic properties.
- Produce a *Process and Instrumentation Diagram* with instruments and pipe sizing.
- Develop *Surface Systems Engineering Design Drawings and Specifications Report*, which should include, but is not limited to the following:
 - High-level executive summary
 - SDGL installation design, including:
 - Specify the pump requirements and equipment.
 - Specify the heat rejection requirements and equipment.
 - Specify the non-condensable gas removal or abatement system(s).
 - Specify electrical power requirements for equipment loads.
 - Specify instrumentation used for monitoring system performance.
 - Specify an optional whole-flow screw expander for power production.

Products:

- Process Flow Diagram
- Process and Instrumentation Diagram
- Surface Systems Engineering Design Drawings and Specifications Report

TASK 5 SITE WORK – SDGL EQUIPMENT INSTALLATION

The goal of this task is to install all SDGL equipment at the designated production well. Site preparation includes receiving the test equipment, securing utilities needed for the testing, installation of the downhole equipment, erection of surface equipment, connecting the downhole and surface equipment, and installation of all controls required for operation and/or data collection.

The Recipient shall:

- ****IMPORTANT NOTE:** Products/deliverables submitted for this task to the CEC should not disclose any confidential information.
- Coordinate with the Project Host to mobilize labor and equipment to prepare the selected production well pad for construction activities.
- Ensure through engineering and administrative controls that health, safety, and environmental, regulatory, and legal requirements are satisfied for these activities.
- Install the SDGL equipment, including the down bore heat exchanger and all surface equipment to affect the safe operation of the SDGL system.
- Perform or cause to be performed all necessary quality assurance testing to ensure the SDGL system can be operated safely.
- Confirm satisfactory operation of all electronic instrumentation, controls equipment, and communication devices as feasible.
- With concurrence of the Project Host, author operating and emergency procedures for the SDGL equipment.
- Develop training materials as necessary for the Project Host or third-party personnel to operate the SDGL equipment.
- Develop *SDGL Equipment Installation Report*, which should include, but is not limited to the following:

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- High-level executive summary (this can be brief)
- A summary of all construction activities required to complete the SDGL installation.
- All reports of quality controls testing as well as records of any systems tests performed by the recipient, the Project Host, or any third-party testing agency.

Products:

- SDGL Equipment Installation Report

TASK 6 PROJECT TESTING AND OPERATIONS

The goal of this task is to commission, startup, test and operate the SDGL project.

The Recipient shall:

- ****IMPORTANT NOTE:** Products/deliverables submitted for this task to the CEC should not disclose any confidential information.
- With concurrence with the Project Host, safely commission and start the SDGL equipment.
- Prepare a *Test Plan* that states the test objectives, specific flow scenarios and other conditions to be tested, test procedures and proper use of facilities, instrumentation, data collection and other appropriate equipment.
- Operate the SDGL equipment and project in accordance with the Test Plan for a sufficient length of time to allow for meeting the project objectives.
- Maintain the equipment as necessary to ensure accurate, reliable data collection as well as operational safety.
- Safely conduct shutdown and demobilization activities upon completion of the testing period.
- Prepare a *Testing and Operations Report*, which should include, but is not limited to the following:
 - High-level executive summary (this can be brief)
 - Summaries of testing and operations, including startup and shutdown activities.
 - Any system upset conditions experienced, major maintenance actions, or other unplanned activities which either interrupted operations or resulted in a loss of data collection.

Products:

- Test Plan
- Testing and Operations Report

TASK 7 EVALUATION OF PROJECT BENEFITS

The goal of this task is to **analyze the results of project testing, apply the results of testing to predict the performance of SDGL in various areas of The Geysers mutually agreed by Recipient and the Project Host, and report the benefits resulting from this project.**

The Recipient shall:

- **Based on measured results from the project, analyze areas of The Geysers selected by Recipient and the Project Host for implementation of SDGL technology. Recipient will construct operational models of the wellbore and reservoir performance to estimate**

Exhibit A Scope of Work GreenFire Energy Inc.

the commercial viability of SDGL in such areas on a large scale that would produce 100MWe or more of power. Recipient will authorize and supervise a project partner to assist as a 3rd party expert on the reservoir dynamics in such selected areas as are applicable to its expertise.

- **The conclusions from this analysis should also be included in the project's Final Report.**
- Complete the *Initial Project Benefits Questionnaire*. The Initial Project Benefits Questionnaire shall be initially completed by the Recipient with 'Kick-off' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Complete the *Annual Survey* each year by January 31st. The Annual Survey includes but is not limited to the following information:
 - Technology commercialization progress
 - New media and publications
 - Company growth
 - Follow-on funding and awards received
- Complete the *Final Project Benefits Questionnaire*. The Final Project Benefits Questionnaire shall be completed by the Recipient with 'Final' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Respond to CAM questions regarding the questionnaire drafts.
- Complete the project profile for the CEC's public online project and recipient directory on the [Energize Innovation website \(www.energizeinnovation.fund\)](http://www.energizeinnovation.fund), and provide *Documentation of Project Profile on EnergizeInnovation.fund*, including the profile link.
- Update annually, at a minimum, the project profile for the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund) annually by January 31st.
- If the Prime Recipient is an Innovation Partner on the project, complete the organizational profile for the CEC's public online project and recipient directory on the [Energize Innovation website \(www.energizeinnovation.fund\)](http://www.energizeinnovation.fund), and provide *Documentation of Organization Profile on EnergizeInnovation.fund*, including the profile link.
- If the Prime Recipient is an Innovation Partner on the project, update annually, at a minimum, the organization profile for the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund) by January 31st.

Products:

- Initial Project Benefits Questionnaire
- Annual Survey(s)
- Final Project Benefits Questionnaire
- Documentation of Project Profile on EnergizeInnovation.fund
- Documentation of Organization Profile on EnergizeInnovation.fund

TASK 8 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

The goal of this task is to conduct activities that will accelerate the commercial adoption of the technology being supported under this agreement. Eligible activities include, but are not limited to, the following:

- Scale-up analysis including manufacturing analysis, independent design verification, and process improvement efforts.

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- Technology verification testing, or application to a test bed program located in California.
- Legal services or licensing to secure necessary intellectual property to further develop the technology.
- Market research, business plan development, and cost-performance modeling.
- Entry into an incubator or accelerator program located in California.

The Recipient Shall:

- Develop and submit a *Technology Transfer Plan (Draft/Final)* that identifies the proposed activities the recipient will conduct to accelerate the successful commercial adoption of the technology.
- Present the *Draft Technology Transfer Plan* to the TAC for feedback and comments.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the *Draft Technology Transfer Plan*. This document will identify:
 - TAC comments the recipient proposes to incorporate into the *Final Technology Transfer Plan*.
 - TAC comments the recipient does not propose to incorporate and explanation why.
- Submit the *Final Technology Transfer Plan* to the CAM for approval.
- Implement activities identified in *Final Technology Transfer Plan*.
- Develop and submit a *Technology Transfer Summary Report (Draft/Final)* that includes high level summaries of the activities, results, and lessons learned of tasks performed relating to implementing the *Final Technology Transfer Plan*. This report should not include any proprietary information.
- When directed by the CAM, develop presentation materials for a CEC- sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the CEC.
- Provide at least (6) six *High Quality Digital Photographs* (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.

Products:

- Technology Transfer Plan (Draft/Final)
- Summary of TAC Comments
- Technology Transfer Summary Report (Draft/Final)
- High Quality Digital Photographs

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: GREENFIRE ENERGY INC.

RESOLVED, that the State Energy Resources Conservation and Development Commission (CEC) adopts the staff CEQA findings contained in the Agreement or Amendment Request Form (as applicable); and

RESOLVED, that the CEC approves Agreement EPC-21-015 with GreenFire Energy Inc for a \$2,705,228 grant to advance the development of its Steam Dominated GreenLoop system in an existing low-production geothermal well. The system is intended to help restore power production of inactive or low production geothermal wells by extracting heat, but not water, via a closed loop, down bore heat exchanger; and

FURTHER BE IT RESOLVED, that the Executive Director or their designee shall execute the same on behalf of the CEC.

CERTIFICATION

The undersigned Secretariat to the CEC does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the CEC held on February 16, 2022.

AYE:

NAY:

ABSENT:

ABSTAIN:

Liza Lopez
Secretariat